REMARKS

Claims 1, 20 and 55-56 have been amended. Claim 4 has been canceled. Claims 1-3, 5-13, 15-37, 55, and 56 are pending in this application. Applicant reserves the right to pursue the original claims and other claims in this or other applications.

Claim 55 stands rejected under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent No. 6,489,643 to Lee. The rejection is respectfully traversed.

Claim 55 recites a pixel cell for an image sensor, the pixel cell comprising "a photodiode for ... amplifying the generated charge, ... formed within a substrate and below an upper surface thereof ... comprising at least two of a first layer having a first band gap and at least two of a second layer having a second band gap, wherein the first layers are alternated with the second layers, and wherein the at least two first layers and the at least two second layers are configured to promote ionization by a first carrier type and suppress ionization by a second carrier type in the presence of an electric field." Lee does not disclose, teach, or suggest each of the above limitations.

Lee fails to disclose, teach, or suggest "a photodiode ... comprising at least two of a first layer having a first band gap" and "at least two of a second layer having a second band gap ... wherein the at least two first layers and the at least two second layers are configured to promote ionization by a first carrier type and suppress ionization by a second carrier type in the presence of an electric field." Instead, Lee discloses a pinned photodiode having a plurality of PN junctions to improve the capacitance of the photodiode. Lee is not concerned with amplifying charge or providing "at least two of a first layer having a first band gap" and "at least two of a second layer having a second band gap ... wherein a difference between energy levels of a conduction band of the first and second layers is greater than a difference between energy levels of a valence band of the first and second layers," as recited by claim 55. For at least these reasons, Applicant respectfully requests the rejection be withdrawn, and the claim allowed.

Claims 1, 4, 11, 15-18, and 56 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,489,643 to Lee in view of U.S. Publication No. 2002/0171077 to Chu. The rejection is respectfully traversed.

Claim 1 recites each of the limitations presented for claim 55. Claim 56 recites each of the limitations presented for claim 55 except for the limitation "formed within a substrate and below an upper surface thereof." For the reasons set forth above, Lee does not disclose, teach or suggest all limitations of claims 1 or 56. Chu is cited as disclosing "a photodiode and a graded buffer layer beneath a bottom layer of the photodiode" and fails to cure the deficiencies of Lee. Office Action, pp. 4-6. Thus, even when considered in combination, Lee and Chu fail to teach or suggest all limitations of claims 1 and 56.

Claims 4, 11, and 15-18 depend from claim 1 and are allowable along with claim 1, and on their own merits.

For at least these reasons, Applicant respectfully requests the rejection be withdrawn, and the claims allowed.

Claim 19 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,489,643 to Lee in view of U.S. Publication No. 2002/0171077 to Chu and U.S. Patent No. 6,232,626 to Rhodes. The rejection is respectfully traversed.

Claim 19 depends from claim 1, and is allowable over the Lee and Chu combination for all the reasons presented for claim 1, and on its own merits. Rhodes is cited as disclosing a pixel cell where the substrate is a silicon-on-insulator substrate, and fails to cure the deficiencies of Lee and Chu. Office Action, p. 7. For at least these reasons, Applicant respectfully requests the rejection be withdrawn, and the claim allowed.

Claims 2-3, 5-8, 12-13, 20-29 and 32-34 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,489,643 to Lee in view of U.S. Publication No.

2002/0171077 to Chu and U.S. Patent No. 5,818,322 to Tasumi. The rejection is respectfully traversed.

Claims 2, 3, 5-8, 12, and 13 depend from claim 1 and are allowable along with claim 1, and on their own merits. Tasumi is cited as disclosing the differences between the valence band energies and the conduction band energies, and does not cure the deficiencies of Lee. Office Action, p. 8.

Claim 20 recites similar limitations to those presented for claim 55. Additionally, claim 20 recites "layers [which] are configured such that a difference between conduction band energies of the first and second materials and a difference between the valence band energies of the first and second materials promotes ionization by a first carrier type and suppresses ionization by a second carrier type." The cited combination does not disclose, teach, or suggest each of the limitations of claim 20.

Claim 32 recites an image sensor comprising "a photodiode formed below an upper surface of a substrate, the photodiode comprising at least two layers of Si alternating with at least two layers of Si_xGe_{1-x}." For at least the reasons presented with respect to claim 20, Lee and Tasumi are not combinable. Even if the references were combinable, which they are not, the cited combination fails to disclose, teach, or suggest "a photodiode formed below an upper surface of a substrate, the photodiode comprising at least two layers of Si alternating with at least two layers of Si_xGe_{1-x}."

The Office Action has failed to meet its burden of providing a *prima facie* showing of obviousness. The Supreme Court recently stated in *KSR Int'l Co. v. Teleflex Inc.* that "the [Graham] factors continue to define the inquiry that controls" a finding of obviousness. 127 S. Ct. 1727, 1734 (U.S. 2007). The Graham factors include determining the scope and content of the prior art, ascertaining differences between the prior art and the claims at issue, and resolving the level of ordinary skill in the pertinent art. *Graham v. John Deere*, 383 U.S. 1, 148 USPQ 459 (1966).

Applicant submits that the Office Action has not properly shown that the Applicant's claims would have been obvious by conducting an examination of the Graham factors. *See* M.P.E.P. § 2141 ("Patent examiners carry the responsibility of making sure that the standard of patentability enunciated by the Supreme Court and by the Congress is applied in each and every case."). Instead, the Office Action merely states that it "would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Lee to have a difference between the conduction band energies of the first layer and the second materials as in Tasumi in order to improve device characteristics, such as enhancing absorption and speed of the image sensor and reducing dark current." Office Action, pg. 11. This statement is not an adequate substitution for an analysis of the Graham factors and does not show obviousness. In fact, it is entirely unclear where such motivation is provided except in the present specification.

Furthermore, even if the references were combinable, which they are not, the cited combination fails to disclose, teach, or suggest "promot[ing] ionization by a first carrier type and suppress[ing] ionization by a second carrier type," as recited by claim 20. The Office Actions relies on column 5, lines 20-30 of Lee as teaching "promot[ing] ionization by a first carrier type and suppress[ing] ionization by a second carrier type." Lee, as presented above, seeks to increase "depletion depth [to increase] the quantum efficiency, thereby producing excellent light sensitivity." Lee, col. 1, ll. 28-29. Lee, in order to improve light sensitivity, discloses "increased capacity to save photogenerated charges [to make] it possible to obtain the desired quantum efficiency." Lee, col. 5, ll. 23-25. The complete implantation of the "middle P- doping region 708, deep N- doping region 706 and shallow N- doping region 710 ... further increas[es] the collection area for photogenerated charges and obtain[s] the quantum efficiency image which the sensor requires." Lee, col. 5, ll. 26-31. This disclosure, however, in no way teaches "promot[ing] ionization by a first carrier type and suppress[ing] ionization by a second carrier type." In short, teaching a method to increase sensitivity does not disclose the ability to discriminate between carrier types. As such, the cited combination does not disclose, teach, or suggest "promot[ing] ionization by a first carrier type and suppress[ing] ionization by a second carrier type." Therefore, the cited combination does not disclose, teach, or suggest all of the limitations of claim 20.

For at least these reasons, Applicant respectfully requests withdrawal of this rejection.

Claims 30, 31, and 35-37 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,489,643 to Lee in view of U.S. Publication No. 2002/0171077 to Chu, U.S. Patent No. 5,818,322 to Tasumi, and U.S. Patent No. 6,232,626 to Rhodes.

Claims 30 and 31 depend from claim 20 and are allowable for all the reasons presented for claim 20, and on their own merits. For claim 30, Rhodes is cited as disclosing readout circuitry connected to a floating diffusion region for reading out charge, and fails to cure the deficiencies of the other references. Office Action, p. 6. For claim 31, Rhodes is cited as disclosing circuitry peripheral to the array, the peripheral circuitry being at a surface of the substrate where the substrate is silicon-on-insulator, and fails to cure the deficiencies of the other references. *Id.*

Claim 35 recites limitations similar to those of claim 20, and is allowable for at least the reasons presented for claim 20, and on its own merits. For claim 35, Rhodes is cited as disclosing a processor system including a processor coupled to the image sensor and with readout circuitry electrically connected to the floating diffusion region, and fails to cure the deficiencies of the other references. Office Action, p. 15.

For at least these reasons, Applicant respectfully requests the rejection be withdrawn.

In view of the above amendment, applicant believes the pending application is in condition for allowance.

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